Summary of Geological Hazard Assessment Model and Approach in China

Feihang Qu [a], Minggao Tang [b]

1State Key Laboratory of Geohazard Prevention & Geoenvironment Protection, Chengdu University of Technology, Sichuan 610059, China

[a]qfhang@126.com, [b]tangminggao07@cdut.cn

Abstract

Geological hazard assessment is the basic of risk assessment and management, which has great significance to disaster prevention and mitigation. In this paper, geological hazard models used in China are divided into three categories ,which is empirical semi-empirical model, mathematical statistics model and the other models respectively. In each of these categories, the most widely uesd and mature model is given a detailed introduction. In order to provide reference for later research work, it is pointed out the advantages and disadvantages of them in the text .

Keywords

Geological hazard, geological hazard assessment, assessment model.

1. Introduction

In rencent years,the regional geological disasters in the word are happened to high frequency, which resulted in a huge loss and a block of human normal life and social development. According to statistic, since 2000, geological disasters caused the deaths of 9635 people only in China, leading to the economic loss of 48.7 billion yuan.Especially in 2011, there are 15804 disasters happened in China,which resulted into 413 casualties [1]. The severe actuality force people to strengthen the research in this aspect,in particular in geological assessment,which is directly related to economic development and social stability.

Recently, geological hazard assessment experienced a rapid development in China and other countries in word,particularly in term of landslide and debris flow disasters.It is may concluded three categories of geological hazard assessment,which is empirical semi-empirical model, mathematical statistics model and the other models respectively, which include information entropy therory model, logic regression model, analytical hierarchy process, etc [2]. In the paper, the most widely uesd and mature model in each of these categories given a detailed introduction. In order to provide reference for later research work, it is pointed out the advantages and disadvantages of them in the text .

2. Empirical semi-empirical model

Empirical semi-empirical model is based on expert knowledge and experience in similiar areas,taken the qualitative or semi-quantitative model for geological hazard assessment. The model includes geomorphologic analysis method, parameter synthesis and AHP, etc. At present, AHP is widely applied in China for its advantages that logic clear and simple calculation.

2.1 Analytical hierarchy process

Analytical hierarchy process are proposed by T.L.Satty in 1970,which is a multi-objective decision analysis method. It divides the complex problems into several factors that associated with orderly

level, making it as a better method of combining quantitative analysis and qualitative analysis.In pratice, AHP divide the target into several levels,get relative weight value of arbitrary two element after comparing in each level,then the judgement matrix of each level is realized. By solving the the biggest eigenvalues of judgement matrix and the corresponding eigenvectors, then get the element relative to its relative importance of all elements in the corresponding leve[3]l.Zhe Wang use AHP evaluated the geological hazard of city Mianyang,compared the result of evaluation with actual geological disasters distribution, the fitting > 90%, which proved the application of analytic hierarchy process to geological hazards assessment results are ideal[4].

AHP as a kind of widely used model, it has the advantages of simple calculation, clearly logic and get influence factors quantified,while it existed the disadvantages of relying too much on expert opinoins,which may lead to a unreasonable result,in other words ,it is a subjective judgment.

3. Mathematical statistics model

Mathematical statistics model based on the various analysis method in statistical, combined it with the knowledge from field investigation as related factors and distribution of geological hazard, then establish a rational assessment model of geological disasters. The method assuming that the development and distribution of geological disasters in the future and the past with the same regularity. According the assume, people can analyse the features of geological disasters by the knowledge of mathematical stastitics. Then establish a statistic model about factors caused geological disasters with geological disasters. After reasonable validation, the model can be used to do some assessment work of geological disasters in the similiar place that has similiar geological environment.

3.1 Bivariate statistical model

Bivariate statistical model assuming that there is no correlation between each factor causing disasters.

Based on the assume,the weight value can be determined after analysing the relationship between each factor causing disasters and geological disasters.Then a bivariate statistical model set. According the calculation method of weight of influencing factor,it can be divided into information entropy therory model, probability index model, the weights of envidence model, etc.

3.2 Information entropy model

As a nonlinear and open system, natural environment always in a self-organizing and non-equilibrium state, which makes it difficult to assess. While, the information entropy express the state of the uncertainty of a system in a quantitative way, that makes it can be better evaluate the probability of geological disaster.

The main idea of the information entropy model is,based on the analysis of the information provided by deformation or destruction area, that people can convert the true value of various factors affecting the regional stability to the information value which reflect the stability condion[5]. It means that the greater the amount of information entropy, the greater the probability of geological disasters in the region, whereas the smaller.Although the informaiton entropy model has the advantages of simple structures and easy implenment, the disvantages of it is the envaluation unit not included the geological concepts especially in rules units,which may reduce its precision.

3.3 Multivariate statistical model

Multivariate statistical model put forward by Cararra and his colleagues in Italy. After many years development and evolution, more approaches of it created. On the whole, it can be classfied regression analysis and discriminant analysis, especially logistic regression models are applied in various fields by scholars all over the world for its advantages.

As the general multivariate regression model, logistic regression model can better solve the problem of the variable values range, which can be used to predict the probability of geological disaster.In the application of logistic regression model, people should convert the related data of influence factors to

digital matrix, then a regression equation is obtained after import data into SPSS software. Use this equation people can calculate the probability of geological disaster in the area [6]. Logistic regression model has advantages of simple in evaluation index, that makes evaluation index have the certain physical meaning,etc, but it requires a lot of data, high demands on the original data.

4. The other models

Due to natural's own characteristics resulte into the complexity of geological disasters, more and more interdisciplinary knowledge, such as nonlinear science theory and artificial intelligence theory, are applied to geological disaster prediction. Among them, the neural network model, the grey clustering model are widely used[7]. In addation ,with the GIS and RS technology develop, some new methods are applied to geological disaster prediction, which all promote the development of China's geological disaster assessment. It is no denying that all the models have advantages and disadvantages, like expert evaluation method is good at the calculation results which is a certain value and can be used in multiple places,while it has a high demand for have master data, whlie the data come from the empirical formula are not accurate enough; artificial neural network do well in calculation process and suitable for the state of unsufficient information,bu the method is controversial at presenmt.

5. Conclusion

There are many different geological hazard assessment model, all of them have certain conditions should be obey ,some advantages and disadvantages exist as well. In general, it can be divided into two categories, subjective judgment and objective analysis.Subjective analysis method makes full use of expert knowledge, so it contains a certain subjectivity; Objective judgment method overcomes the subjectivity, but too dependent on data, the expert knowledge may ignored. Therefore, in the actual application, people should combine analysis of subjective and objective, then select an appropriate model to do the work of geological hazard assessment.

Model is the reflection of reality, only a high level analysis of relationship of geological environment and geological hazard achieved can a rational model be established. In the future, people should strength the research of mechanism of geological hazard, on the base of it, more reasonable models can be set, more accurate conclusion can be obtained.

References

[1] The national bureau of statistics of the People's Republic of China: China statistical yearbook (China statistics press, China 2012). (In Chinese)

[2] Y. Chen, Q. Z. Li, Q. J. Wang. Summary of Regional Geological Hazard Assessment Model, Journal of institute of Disaster Prevention, vol. 12 (2010), 42-45.(In Chinese)

[3] C. Xu. Actual landslides as most objective standard for validation of landslide hazard assessment result. Journal of Engineering Geology, vol. 21(2013), 908-911.(In Chinese)

[4] Z, Wang, F, C, Yi. AHP-based evaluation of occurrence easiness of geological disasters in Mianyang City, Journal of Natural Disasters, vol. 18(2009), 14-23.(In Chinese)

[5] J. Du, Q, H, Yang, Y, Jia, et al. Hazard evaluation of secondary geological disaster based on GIS and information value method, Earth Science—Journal of China University of Geosciences, vol. 35(2010), 324-330.(In Chinese)

[6] G, R, Zhang, L, X, Chen, K, L, Yin. Landslide hazard zonation of Yongjia County in Zhejiang Province, Hydrogeology and Engineering Geology, Vol.3 (2005) p.27-31.(In Chinese)

[7] Z, H, Shang, X, L, Liu. An overview of Hazard ang vulnerability assessment method of geological disasters. Second posiunmon disaster risk analysis and management in China littoral regions (Atlantis Press, 2014).p. 212-216. (In Chinese)